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A Survey Based Study on The Spread of Infectious Diseases in Saudi Arabia in Context to Vaccination in Perspective of Climate Changes

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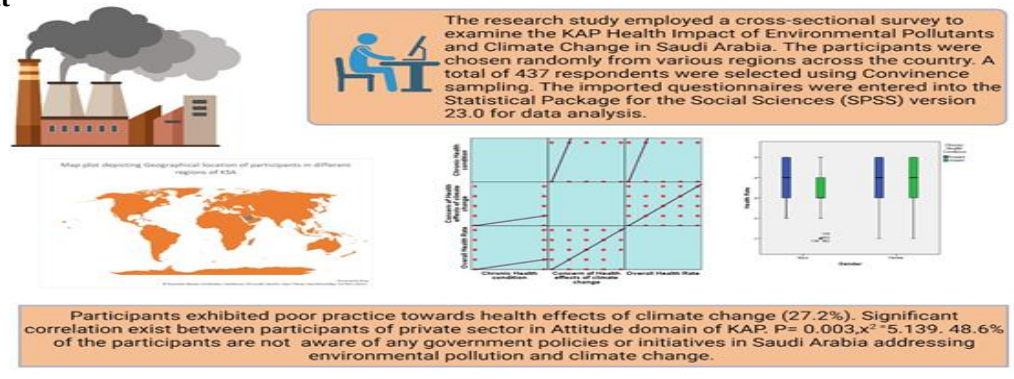
Abstract: **Background:** Submission: Saudi Arabia is known for its dry climate. This arid climate of the region makes its ecosystems highly susceptible, with limited water resources and vulnerable agricultural fields. The 2007 report by the intergovernmental panel on climate change highlighted the global impact of climate change on precipitation patterns, which has been evident in Saudi Arabia through an increase in rainfall. Therefore, it is crucial to comprehend the public's awareness and perceptions of environmental issues and climate change that have an impact on their health and immune system; Accepted: Nov 07, 2022; Published: Nov. 15, 2022. **Materials & methods:** The research study employed a cross-sectional survey to examine the KAP health impact of environmental pollutants and climate change in Saudi Arabia. The participants were chosen randomly from various regions across the country. A total of 437 respondents were selected using convenience sampling. The imported questionnaires were entered into the statistical package for the social sciences (SPSS) version 23.0 for data analysis. **Results:** 80.78% of the participants were Female and 19.22% of the participants were Male. Participants have fair knowledge on immunological and health effect of environmental pollution and climate change (94.3 and 87.5%) respectively. Participants are well aware of influence of environmental pollutants and climate change on spread of infectious diseases 51% - 94%. Significant correlation exists between participants of private sector in Attitude domain of KAP. P= 0.003, x2 =5.139. **Conclusion:** Significant correlation exist between participants of private sector in Attitude domain of KAP. P= 0.003, x2 =5.139. Participants are well aware of influence of environmental pollutants and climate change on spread of infectious diseases 51-94%. The health mission in Saudi Arabia has integrated with other missions in order to address diseases that are sensitive to climate change. It is crucial to enhance the knowledge and skills of general public regarding climate change and its impact on health.

Key Words: Vaccine, Health Condition, Infectious Diseases, Climate Change, Knowledge, Attitude, Practices.

Graphical Abstract



INTRODUCTION

The quality of air is significantly impacted by climate, which plays a crucial role in various aspects. Meteorological factors like temperature, humidity, wind patterns, and vertical mixing have the potential to affect the emission, transportation, dispersion, chemical transformation, and deposition of pollutants [1]. It is widely anticipated that climate change will have a detrimental effect on air quality in densely populated areas. This is primarily due to alterations in atmospheric ventilation and dilution, precipitation patterns, removal processes, and atmospheric chemistry [2]. By the end of the century, air quality could be significantly diminished due to the increased frequency and size of wildfires linked to climate change [3]. The correlation between environmental pollution and climate change is undeniable. Climate change is a direct consequence of the degradation of our planet, as pollutants like black carbon, methane, tropospheric ozone, and aerosols disrupt the ecological balance [4]. Consequently, the Earth's temperature rises, resulting in the alarming melting of ice, icebergs, and glaciers. Furthermore, these climatic shifts have a profound impact on the occurrence and prevalence of both indigenous and imported infections [5]. Climate and weather patterns strongly influence the duration, timing, and severity of disease outbreaks, reshaping the global landscape of infectious diseases [6]. Diseases transmitted by mosquitoes, whether parasitic or viral, are particularly sensitive to climate variations. Warming temperatures not only shorten the incubation period of pathogens but also alter the geographical distribution of disease-carrying vectors [7]. Additionally, the warming of water bodies due to climate change contributes to a higher incidence of waterborne infections [8].

The occurrence of epidemics is closely linked to natural climate disasters and storms, which appear to be more frequent in recent times [9]. Moreover, malnutrition and immune system imbalances are associated with the emergence of infectious diseases, posing significant threats to public health [10]. People who are exposed to elevated levels of air pollutants encounter various disease symptoms and conditions of varying severity. These effects can be categorized into short-term and long-term impacts that have an adverse effect on one's health [11]. The immediate consequences of air pollution are transient and encompass mild discomfort, such as eye and skin irritation, nasal congestion, throat irritation, wheezing, coughing, chest tightness, and breathing difficulties. They can also escalate to more severe conditions like asthma, pneumonia, bronchitis, and respiratory and cardiovascular issues [12]. Additionally, short-term exposure to air pollution can result in headaches, nausea, and dizziness. On the other hand, the enduring effects of air pollution are persistent, lasting for years or even an entire lifetime, and can ultimately lead to fatality [13]. Moreover, prolonged exposure to various environmental pollutants can also trigger the development of different types of cancer in the long run [14].

For the past decade, both urban and rural residents in Saudi Arabia have been experiencing the consequences of climate change. Saudi Arabia is known for its dry climate [15]. In certain regions, temperatures can exceed 50 degrees Celsius. Rainfall is extremely scarce, with an average annual precipitation of approximately 100 mm. Nevertheless, in the western areas of the country, rainfall can reach up to 500 mm per year [16]. This arid climate of the region makes its ecosystems highly susceptible, with limited water resources and vulnerable agricultural fields [17]. The 2007 report by the Intergovernmental Panel on Climate Change highlighted the global impact of climate change on precipitation patterns, which has been evident in Saudi Arabia through an increase in rainfall [18]. Unfortunately, this rises in rainfall, combined with the existence of unplanned settlements in our major cities, has resulted in a heightened risk of flash flooding and other Environmental hazards [19-20]. As far as we know, there have been not much surveys conducted to evaluate the Health Impact of Environmental Pollutants and Climate Change among KSA citizens. Therefore, it is crucial to comprehend the public's awareness and perceptions of environmental issues and climate change that have an impact on their health and immune system. This understanding will play a significant role in assisting the nation's sustainable development plans and shaping policies.

MATERIALS AND METHODS

Participant Recruitment

The research study employed a cross-sectional survey to examine the KAP health impact of environmental pollutants and climate change in Saudi Arabia. The participants were chosen randomly from various regions across the country. A total of 437 respondents were selected using conveniences sampling. To be included in the study, individuals had to be 18 years old or older and have resided in different parts of Saudi Arabia for at least one year. On the other hand, individuals below 18 years of age and those who had recently relocated to Saudi Arabia were excluded from the study**.**

Questionnaire

Questionnaire was executed in both English and Arabic language and comprised of four parts.

Part 1: We collected eight pieces of information that pertained to general details, such as the region of residence, age, gender, educational level, and employment status.

Part 2: Knowledge related to the impact of environmental pollutants and climate change on general health. In this section, participants were given questions regarding their knowledge about the effects of environmental pollutants and climate change on overall health. A correct answer was assigned a score of 1, while an incorrect answer received a score of 0. These scores were then categorized into two levels: high knowledge level and low knowledge level.

Part 3: Attitudes regarding vaccination and measures to prevent the spread of infectious diseases in the context of environmental pollutants and climate change. A higher score

indicated a more positive attitude towards these topics.

Part 4: Implementation of protective measures to minimize the potential immunological impacts of environmental pollutants and climate change in Saudi Arabia. A higher score signifies enhanced practice.

Statistical Analysis:
The imported questionnaires were entered into the statistical package for the social sciences (SPSS) version 23.0 for data analysis. The frequency percentage was used to analyse the demographic data and KAP of the participants regarding the health impact of environmental pollutants and climate change in Saudi Arabia. Chi-square tests were conducted to examine the demographic factors, such as education level. Scatter plots and box plots were utilized to illustrate the correlation between dependent and independent factors.

RESULTS

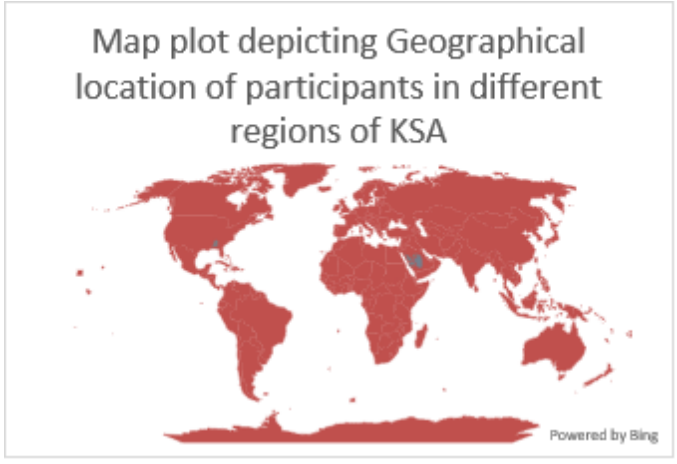


Figure 1: Map plot depicting geographical location of participants in different regions of KSA. among 437 participants, majority of them are from (Jeddah 228, 52.1%), followed by Riyadh (54,15.5%) and tiniest contribution from participants of Abha, Al Katif, Qassim, Zahran, Al-Kharj, Yanbu and Al Jubail etc.

Table 1: City wise descriptive statistics data for study.

Sr. No.	City of Country	Frequency in Count
1	Jeddah	228
2	Riyadh	54
3	Madinah	32
4	Makkah	41
5	Yanbu	3
6	Al Bahah	17
7	Rabig	4
8	Kubar	6
9	Damam	10
10	Kamis Meshead	2
11	Sharorarh	1
12	Al Jubail	19
13	Al Katif	1
14	Abha	13
15	Qassim	1
16	Zahran	4
17	Al-Kharj	1

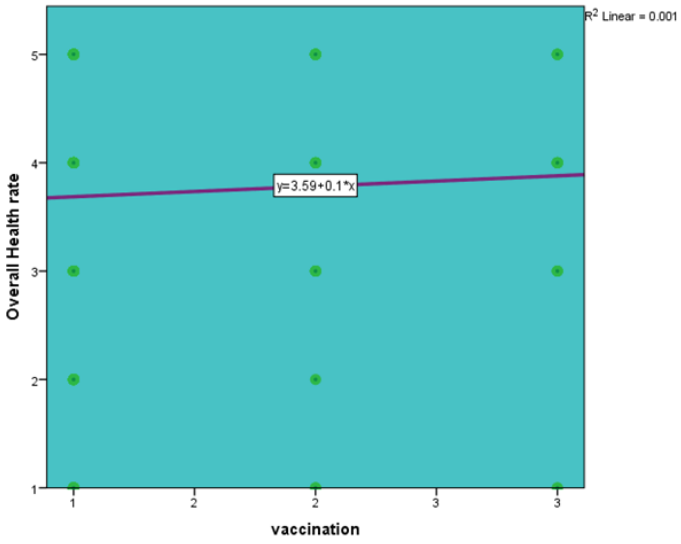


Figure 2: Correlation between health condition and vaccination. There is no significant correlation between vaccination and heath condition. As health condition improves, number of populations being vaccinated decreases (R2 = 0.001- indicates little variation between dependant and independent variables).

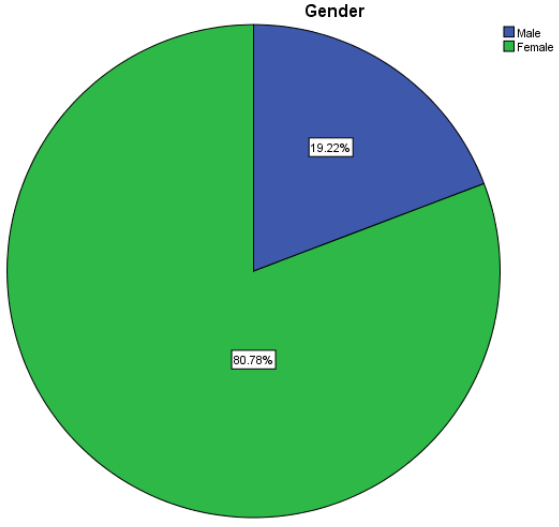


Figure 3: Shows gender distribution of study participants. 80.78% of the participants were Female and 19.22% of the participants were Male.

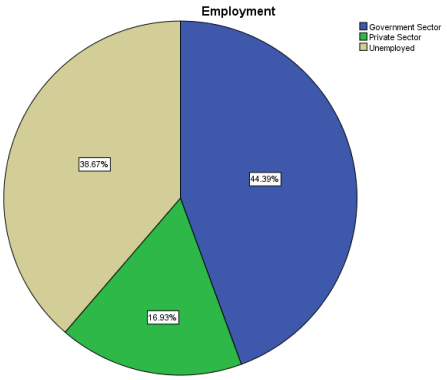


Figure 4: Showcase employment distribution of study population. 44.39% are from government sector, 38.67% were unemployed and 16.39% were from private sector.

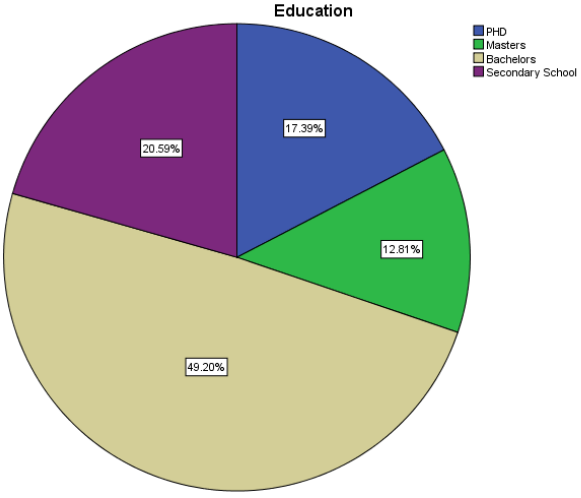


Figure 5: Shows educational profile of study participants. 49.20% of the participants completed Bachelor's degree, 17.39% were PHD holders, 20.59% completed secondary schooling and 12.81% of participants completed master's degree.

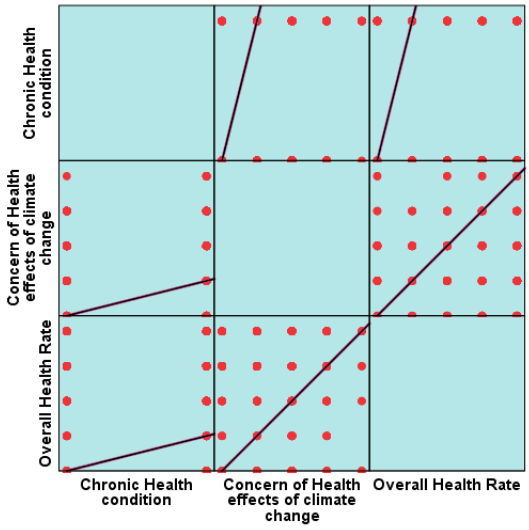


Figure 6: Scatter matrix plot depicting correlation between health rate, chronic health condition and participant's concern of health effects of climate change. Positive correlation exists between Concern of health effects of climate change and health rate. As concern of health effects of climate change increases, health rate increases. This mean people who are concerned about health effects of climate are healthier when compared to their counterparts.

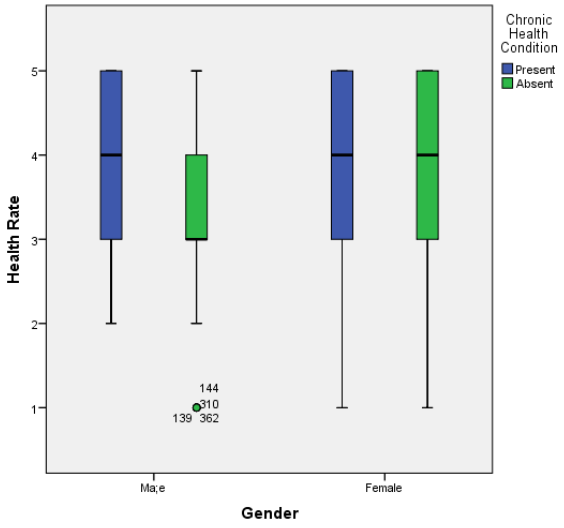


Figure 7: Depicting presence and absence of a chronic health condition among gender. Among male gender there is positive skewed distribution with median =4 for male population with chronic health condition and median =3 for male population with no chronic health condition

Table 2: Response of participants to knowledge-based questions. Correct response graded 1 and Incorrect response graded 0. Mean score of responses were 74.8%. Score above 74.8% were considered to be high knowledge level. Participants have fair knowledge on immunological and health effect of environmental pollution and climate change (94.3% and 87.5% respectively.

Sr. No.	KQ	Frequency (%) correct response	Frequency (%) Incorrect response
1	K1	412 (94.3%)	25 (5.7%)
2	K2	226 (51.8%)	211 (48.2%)
3	K3	343(87.5%)	94 (12.5%)

Table 3: Response of participants to attitude based questions. Positive attitude graded 1 and negative and doubtful attitude graded graded 0. Mean score for responses were 48%. Score above 48% were considered to be Positive attitude. Participants are well aware of influence of environmental pollutants and climate change on spread of infectious diseases 51% - 94%.

Sr. No.	AQ	Frequency (%) correct response	Frequency (%) Incorrect response
1	A1	380 (86.5%)	57 (13.5%)

2	A2	273 (62.2%)	164(37.8%)
3	A3	322 (73.7%)	115 (26.3%)

Table 4: Response of participants to practice based questions. A high score indicated improved practice. Mean score for responses were 45.6%. Score above 45.6% were considered to be good practice. Participants exhibited poor practice towards health effects of climate change (27.2%).

Sr. No.	PQ	Frequency (%) correct response	Frequency (%) Incorrect response
1	P1	214 (49%)	236 (51%)
2	P2	119 (27.2%)	328 (72.8%)
3	P3	322 (73.7%)	115 (26.3%)
4	P4	216 (49.4%)	221 (50.6%)

Table 5: Depicts correlation between employment and KAP factor. Significant correlation exists between participants of private sector in Attitude domain of KAP. P= 0.003,x2 =5.139.

Employment	Knowledge			Attitude			Practice		
	P value	X^2	Likelyhood ratio	P value	X^2	Likelyhood ratio	P value	X^2	Likelyhood ratio
Government Sector	0.226	5.663	6.717	0.505	7.718	7.079	0.126	4.510	4.479
Private Sector	0.263	5.246	4.433	0.003	5.139	5.269	0.195	7.654	9.227
Non-Employed	0.251	9.119	9.503	0.201	7.185	7.212	0.808	2.306	2.402

DISCUSSION

This research employed a survey questionnaire to evaluate the knowledge, attitudes, and practices (KAP) of the participants. Unlike previous studies conducted in Saudi Arabia (KSA), our study encompassed a diverse population from various regions and employment sectors. This approach facilitated the discovery of valuable insights regarding the effective implementation of environmental policies in Saudi Arabia [21-25]. Among 437 participants, 80.78% of the participants were Female and 19.22% of the participants were Male. 49.20% of the participants completed Bachelor's degree, 17.39% were PHD holders, 20.59% completed secondary schooling and 12.81% of participants completed Master's degree. 44.39% are from government sector, 38.67% were unemployed and 16.39% were from private sector. 78.5% of the Participants observed a rise in allergies or respiratory issues either in themselves or others family members which was most likely to be of environmental origin. This is in accordance with a study by Alahmadi where most participants (94.8%) believed that air pollution could be a causality of cardiopulmonary disease, and 83.2% thought that air pollution contributes to asthma [26]. Only 11.7% were concerned about the health effects of climate change in Saudi. In research by Qian et al, a mere 17.1% of the inhabitants conveyed contentment regarding the air quality in Changchun [27]. Nevertheless, a significant 80% of the residents displayed willingness to mitigate the effects of haze pollution through their personal endeavours, while 63.8% of the residents acknowledged the shared responsibility of every citizen in combating haze pollution. These outcomes align with the conclusions drawn from earlier investigations [28,29]. Consequently, it can be inferred that the majority of residents possess a strong consciousness and a sense of duty to actively involve themselves in the management of haze pollution [30].

49 % of our study participants believe Hand hygiene practices aids to prevent the spread of infectious diseases in the context of environmental and climate change. This is supported by Muindi et al study A total of 56.3% of the residents practiced protective measures initiatively when exposed to haze pollution [31]. Mean score of responses were 74.8%. Participants have fair knowledge on immunological and health effect of environmental pollution and climate change (94.3% and 87.5% respectively. Larijani et al study revealed that the average knowledge score was 26.27 ± 5.73. A good level of knowledge was observed in 23% of the participants, while 61.3% and 15.7% had a fair and poor level, respectively [32]. Participants are well aware of influence of environmental pollutants and climate change on spread of infectious diseases 51% - 94%. Pretto et al. and Aryal et al. have documented that a significant level of consciousness and apprehension regarding air pollution motivates individuals to take precautionary measures against it. There is a clear positive association between these two factors. Consistent with earlier research outcomes, the current study's findings indicate that traffic police officers exhibit the highest levels of attitudes and practices, possibly due to their frequent outdoor presence and exposure to haze pollution, which enhances their sense of self-protection [33-34].

Participants exhibited poor practice towards health effects of climate change (27.2%). The findings of Semenza et al investigation revealed that, 39.6% of the inhabitants achieved a commendable practice score, while approximately 66% achieved a moderate practice score. Out of the four categories, college students exhibited a significant difference in practice scores compared to the other groups ($p < 0.05$), despite having the highest rate of awareness and knowledge score [35]. Significant correlation exists between participants of private sector in Attitude domain of KAP. P= 0.003,x2 =5.139. However, study conducted in Nanjing, China, a cross-

sectional study revealed that individuals in white-collar occupations obtained higher knowledge scores in comparison to those in blue-collar occupations. The study investigators put forth the hypothesis that individuals in higher-skilled roles might have had greater access to resources and health-related information, which could have contributed to their higher knowledge scores when compared to their lower-skilled counterparts [36]. 48.6% of the participants are not aware of any government policies or initiatives in Saudi Arabia addressing environmental pollution and climate change. However Saudi Arabia has taken steps towards diversifying its economy and reducing its reliance on oil by implementing its 2030 national vision [37]. This vision aims to shift the country towards a more environmentally friendly economy. As part of this plan, Saudi Arabia has committed to investing in clean energy projects, including solar energy, with the goal of reducing annual energy emissions to 130 million tons by 2030 [38]. Additionally, Saudi Arabia has joined international efforts in combating climate change and was an official endorser of the Paris Agreement in November 2016 [39].

Strengths of the study

The survey was derived from a prior investigation and underwent a preliminary examination in a comparable environment. Subsequently, questionnaire was framed both in English and Arabic language for facilitating better understanding to study participants and also to mitigate any challenges encountered during the process of gathering data.

Limitations of the study

Like any other cross-sectional study design, this specific design presents both the exposure and outcome at the same time. As a result, it is not feasible to establish a cause-and-effect relationship solely relying on this study design.

CONCLUSION

Participants are well aware of influence of environmental pollutants and climate change on spread of infectious diseases 51% - 94%. Significant correlation exists between participants of private sector in Attitude domain of KAP. P= 0.003,x2 =5.139. The health mission in Saudi Arabia has integrated with other missions in order to address diseases that are sensitive to climate change. It is crucial to enhance the knowledge and skills of general public regarding climate change and its impact on health. The importance of health effects and preparedness in the face of climate change is being recognized globally, and our study focuses on the current situation in KSA. Additionally, it presents an approach, along with the challenges, to assess the knowledge, attitudes, and practices (KAP) of general public at the country-level.

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Authors Contribution

All authors are participating in the preparation of the manuscript draft, data collection, data filtration, making table, rough draft of manuscript and manuscript revisions and its final draft.

Conflict of Interest

Authors declare they don't have any conflict of interest.

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REFERENCES

1. Kinney PL. Climate change, air quality, and human health. Am J Prev Med. 2008;35(5):459–67.
2. Fiore AM, Naik V, Leibensperger EM. Air quality and climate connections. J Air Waste Manag Assoc. 2015;65(6):645–85.
3. Liu Y, Stanturf J, Goodrick S. Trends in global wildfire potential in a changing climate. For Ecol Manag. 2010;259(4):685–97.
4. D'Amato G, Pawankar R, Vitale C, Maurizia L. Climate change and air pollution: effects on respiratory allergy. *Allergy Asthma Immunol Res*. 2016; 8:391–5. 10.4168/aair.2016.8.5.391.
5. Bezirtzoglou C, Dekas K, Charvalos E. Climate changes, environment and infection: facts, scenarios and growing awareness from the public health community within Europe. *Anaerobe*. 2011; 17:337–40. 10.1016/j.anaerobe.2011.05.016.
6. Castelli F, Sulis G. Migration and infectious diseases. *Clin Microbiol Infect*. 2017; 23:283–9. 10.1016/j.cmi.2017.03.012.
7. Watson JT, Gayer M, Connolly MA. Epidemics after natural disasters. *Emerg Infect Dis*. 2007; 13:1–5. 10.3201/eid1301.060779.
8. Lindh E, Argentini C, Remoli ME, Fortuna C, Faggioni G, Benedetti E, Amendola A, Marsili G, Lista F, Rezza G, Venturi G. The Italian 2017 outbreak chikungunya virus belongs to an emerging Aedes albopictus–adapted virus cluster introduced from the Indian subcontinent. InOpen forum infectious diseases 2019 Jan (Vol. 6, No. 1, p. ofy321). US: Oxford University Press.
9. Nakano T, Otsuki T. [Environmental air pollutants and the risk of cancer]. (Japanese). *Gan To Kagaku Ryoho*. 2013; 40:1441–5.
10. Kurt OK, Zhang J, Pinkerton KE. Pulmonary health effects of air pollution. *Curr Opin Pulm Med*. (2016) 22:138–43.
11. Guarnieri M, Balmes JR. Outdoor air pollution and asthma. *Lancet*. 2014; 383:1581–92. 10.1016/S0140-6736(14)60617-6
12. Jiang X-Q, Mei X-D, Feng D. Air pollution and chronic airway diseases: what should people know and do? *J Thorac Dis*. 2016; 8: E31–40.
13. Bourdrel T, Bind M-A, Béjot Y, Morel O, Argacha J-F. Cardiovascular effects of air pollution. *Arch Cardiovasc Dis*. 2017; 110:634–42.
14. DeNicola E, Aburizaiza OS, Siddique A, Khwaja H, Carpenter DO. Climate change and water scarcity: the case of Saudi Arabia. Annals of Global Health. 2015;81(3):342–53.
15. Al Zawad FM, Aksakal A. Impacts of climate change on water resources in Saudi Arabia. Global Warming: Springer; 2010; 3: 511–23.
16. Almazroui M, Islam MN, Balkhair KS, Şen Z, Masood A. Rainwater harvesting possibility under climate change: a basin-scale case study over western province of Saudi Arabia. Atmospheric Research. 2017;189:11–23.
17. Chowdhury S, Al-Zahrani M. Implications of climate change on water resources in Saudi Arabia. Arabian

Journal for Science and Engineering. 2013;38(8):1959–71.
18. Williams JB, Shobrak M, Wilms TM, Arif IA, Khan HA. Climate change and animals in Saudi Arabia. Saudi journal of Biological Sciences. 2012;19(2):121–30.
19. Asadieh B, Krakauer NY. Global change in streamflow extremes under climate change over the 21st century. Hydrology and Earth System Sciences. 2017;21(11):5863–74.
20. shahzad A, Ullah S, Dar AA, Sardar MF, Mehmood T, Tufail MA, et al. Nexus on climate change: agriculture and possible solution to cope future climate change stresses. Environmental Science and Pollution Research. 2021;28(12):14211–32. WOS:000612905900013.
21. Mu'azu, N.D., Abubakar, I.R. & Blaisi, N.I., Public acceptability of treated wastewater reuse in Saudi Arabia: Implications for water management policy. Science of the Total Environment, 721, 137659, 202.
22. Almulhim, A.I. & Abubakar, I.R., Understanding public environmental awareness and attitudes toward circular economy transition in Saudi Arabia. Sustainability. 13; 10157, 2021
23. Arbuckle JG, Morton LW, Hobbs J. Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: Evidence from Iowa. Climatic Change. 2013;118(3):551–63.
24. Fathy AM, Khalil NS, Taha NM, M.Abd-elbaky M: Nurse's knowledge and practice regarding medication errors in critical care units: descriptive study. Minia Sci Nurs J. 2020, 8:111-20.
25. Al-Shidi HK, Ambusaidi AK, Sulaiman H: Public awareness, perceptions and attitudes on air pollution and its health effects in Muscat, Oman. J Air Waste Manag Assoc. 2021, 71:1159-74. 10.1080/10962247.2021.1930287
26. Naqvi R, Devi AS. Does general public aware about air pollution? What is their attitude on health and environment? A Narrative Review. International Journal of Advanced Scientific Research. 2019;4(3):40-2.
27. Qian X, Xu G, Li L, Shen Y, He T, Liang Y, Yang Z, Zhou WW, Xu J. Knowledge and perceptions of air pollution in Ningbo, China. BMC Public Health. 2016;16(1):1138
28. Yang S, Shi L. Public perception of smog: a case study in Ningbo City, China. J Air Waste Manage Assoc. 2017;67(2):219–30.
29. Jia P, Cai L. Investigation on defence capability and information needs of haze/fog in Changping District, Beijing. Chinese Journal of Health Education. 2014;12:1076–9.
30. Wang R, Yang Y, Chen R, Kan H, Wu J, Wang K, Maddock JE, Lu Y.Knowledge, attitudes, and practices (KAP) of the relationship between air pollution and children's respiratory health in Shanghai, China. Int J Environ Res Public Health. 2015;12(2):1834–48.
31. Muindi K, Egondi T, Kimanimurage E, Rocklov J, Ng N: "We are used to this": a qualitative assessment of the perceptions of and attitudes towards air pollution amongst slum residents in Nairobi. BMC Public Health, 14,1(2014-03-05) 2014, 14(1):226–226.
32. Larijani M: Assessment of environmental awareness among higher primary school teachers. J Hum Ecol. 2010; 31:121-4.
33. Pretto LD, Acreman S, Ashfold MJ, Mohankumar SK, Camposarceiz A. The link between knowledge, attitudes and practices in relation to atmospheric haze pollution in peninsular Malaysia. PLoS One. 2015; 10(12): e0143655.
34. Aryal Bhandari A, Gautam R, Bhandari S. Knowledge and practice on prevention of respiratory health problems among traffic police in Kathmandu, Nepal. International scholarly research notices. 2015; 1: 635.
35. Semenza JC, Wilson DJ, Parra J, Bontempo BD, Hart M, Sailor DJ, George LA. Public perception and behavior change in relationship to hot weather and air pollution. Environ Res. 2008;107(3): 401–11.
36. Chen W, Ren H, Wang N, Xiong Y, Xu F: The relationship between socioeconomic position and health literacy among urban and rural adults in regional China. BMC Public Health. 2021; 21:527.
37. Orton, P. et al., New York city panel on climate change 2019 report. Chapter 4: Coastal flooding. Annals of the New York Academy of Sciences. 2019; 1439(1): 95–114.
38. Al-Shidi, H. K., H. Sulaiman, H. A. Al-Reasi, F. Jamil, and M. Aslam. 2020a. Human and ecological risk assessment of heavy metals in different particle sizes of road dust in Muscat, Oman. *Environ. Sci. Pollut. Res.*2020;0944-1344:1–14. doi:10.1007/s11356-02009319-6.
39. Ambusaidi, A., M. George, A. Killing, M. Stanisstreet, E. Boyes, and N. Taylor. 2014. Omani school and university students' opinions about public transport: Incentives and disincentives. *Econ. Environ. Studs.* 2014; 2 (30) :97–123.